Journal of Economic Growth, 2: 131–153 (June 1997)

Convergence Revisited

CHARLES I. JONES

Stanford University

The recent literature on convergence has departed from the earlier literature by focusing on the shape of the production function and the rate at which an economy converges to its own steady state. This article uses advances from the recent literature to look back at the question that originally motivated the convergence literature: what will the distribution of per capita income look like in the future? Several results are highlighted by the analysis, including the suggestion that there is little reason to expect the United States to maintain its position as world leader in terms of output per worker.

Keywords: economic growth, convergence, world income distribution

JEL classification: O40, E10

1. Introduction

What will the distribution of world per capita income and productivity look like in the future? This is the question that spawned the empirical convergence literature, beginning with Abramovitz (1986) and Baumol (1986). These two studies developed the essential point that the richest countries in the world appear to exhibit convergence while the world as a whole does not. Subsequent research by Barro (1991) and Mankiw, Romer, and Weil (1992) documented the presence of "conditional convergence": once one controls for differences in factor accumulation, countries appear to approach their own steady states at a fairly uniform rate of, say, 2 percent per year.[1] Much of the later empirical work on growth has grappled with interpreting this finding in the context of neoclassical and endogenous growth theory and with estimating parameters related to the shape of the production function. In this later work, however, the empirical growth literature has largely neglected the question that motivated the focus on convergence in the first place. Countries are approaching different steady states at a common rate, but how different are the steady-state values that they are approaching? This article returns to this original question.

The methodology underlying the article draws on a standard neoclassical growth setup. We consider a production function for output that depends on physical capital, human capital, labor, and technology. Following the methods first used by Solow (1956), it is straightforward to characterize the steady-state distribution of per capita income as a function of population growth rates, physical investment rates, human capital investment rates, and steady-state (relative) technologies. With estimates of these key variables, one can analyze empirically the steady-state distribution of per capita income implied by current policy regimes in place around the world and compare this distribution to current and past distributions.[2]

Despite the simplicity of the techniques used here, several interesting conclusions emerge. First, in many of the variations of the model, the steady-state distribution of per capita income is broadly similar to the 1990 distribution, particularly for the poorer half of the sample. For example, assuming relative total factor productivity levels have reached their steady-state distribution in 1990, the R^2 between the (log of) per capita income in 1990 and per capita income in the steady state is 0.96. In contrast, the R^2 comparing the 1960 and the 1990 distributions is 0.81.

Second, despite this broad similarity, there are some interesting differences between the 1990 distribution and the steady-state distribution. For example, most of the newly industrializing countries and a number of OECD economies have not reached their steady-state level, so that important changes in their relative incomes are predicted to occur based on policies currently in place. For example, the divergence in incomes that occurred from 1960 to 1990 among the bottom two-thirds of the income distribution can be expected to continue.

Third, the analysis highlights the importance of total factor productivity (TFP) levels and TFP convergence for the evolution of the income distribution. The framework in this article is the neoclassical growth model, so that differences in technologies, which we associate with TFP, are exogenously given. However, we consider two extreme cases to "bound" the possibilities: that 1990 TFP levels reflect steady-state differences and that all countries eventually achieve at least the U.S. TFP level. For countries whose neoclassical transition dynamics have run their course, this first possibility may not be unreasonable. On the other hand, economies such as Japan and Korea that exhibit continued neoclassical transitions are likely to experience additional technological catch-up. With respect to TFP levels, we find three main results. First, the variation in total factor productivity levels across countries is large; the standard deviation of Harrod-neutral TFP (in logs) is about two-thirds the standard deviation of log GDP per worker. To the extent that we associate technology with total factor productivity, technology levels differ substantially across economies. Second, U.S. TFP is less than 80 percent of the maximum TFP level observed in the sample, suggesting that differences in productivity may reflect more than differences in technology.[3] Third, allowing for complete technological convergence has important effects on the evolution of the income distribution, and future research should focus more on the determinants of technological convergence.

Finally, the model predicts a great deal of "overtaking" in per capita incomes. The analysis emphasizes that simple neoclassical growth models are consistent with a kind of growth miracle and with changes in leaders in the world distribution of income. In general, the analysis considered here suggests that there is no reason to think that the United States will continue to have the world's highest output per worker, observed in both 1960 and 1990. Economies such as Spain, Singapore, France, and Italy are examples of economies with output per worker predicted to be 9 to 40 percent higher than in the United States, based on current policies.

Although much of the convergence literature after Abramovitz and Baumol has focused on rates of convergence, an important exception to this characterization is work by Quah (1993, 1996), who focuses explicitly on the shape of the income distribution. In this work, the unit of observation can be thought of as the income distribution itself at a point in time. Quah examines the dynamics of the income distribution between 1960 and 1990 and projects these dynamics forward to make predictions about the shape of the steady-state distribution. His main finding is that the world is moving toward a bimodal income distribution. The approach here is complementary, with an important difference being that the unit of observation is a country at a point in time. We use a neoclassical growth model to pin down the economic determinants of relative incomes and then use estimates of those determinants to predict the steady-state distribution. One advantage of this approach is that individual countries can be tracked as the income distribution evolves.

The article proceeds as follows. Section 2 reviews the world distribution of income and how it changed from 1960 to 1990. Section 3 motivates the production function approach used to analyze the cross-section distribution of income per person, while Section 4 discusses the data. Section 5 uses this approach together with data on investment, population growth, and technology to characterize the steady-state distribution under various assumptions. Finally, Section 6 offers concluding comments.

2. Relative Income, 1960 to 1990

This section reviews two main findings of the convergence literature to illustrate the techniques we will use later in the article. First, in samples of rich countries, such as the OECD, per capita incomes have converged in the post–World War II era. Second, in large samples of countries (the “world”), per capita incomes have not converged in the postwar era. Typically, this finding is documented by examining growth rates plotted against initial incomes or by focusing on the cross-sectional standard deviation of (log) GDP per worker.

Figure 1 reviews this finding using a slightly different methodology. The figures plot the distribution of GDP per worker relative to the United States in 1960 and 1990.[4] In Figure 1, the countries have been sorted in both periods in ascending order of productivity.[5] This has the advantage of making the figure very easy to read, but it makes it impossible to say anything about how countries move within the distribution.

The earlier results from the convergence literature are apparent from this figure, and even refined slightly. Breaking the distribution at about the 70th percentile, one can see two results. First, above the 70th percentile, the convergence of GDP per worker relative to the United States is apparent in the flattening of the income distribution. Second, among the bottom two-thirds or three-quarters of the distribution the reverse appears to be true. For this subsample, the relatively rich countries (which are in absolute terms the countries in the middle of the distribution) became relatively richer and the relatively poor countries (which are also absolutely the poor countries) became relatively poorer. A significant divergence of GDP per worker characterizes the bottom two-thirds of the distribution between 1960 and 1990.

These results can also be seen using a different methodology in Figure 2. Using a log scale, this figure plots GDP per worker relative to the United States in 1960 and 1990, so that departures from the 45 degree line indicate changes in the income distribution. Substantial changes occurred over this thirty-year period, with countries like Japan and Hong Kong rising from relative incomes of about 20 percent to relative incomes of more than 60 percent and Venezuela falling from about 85 percent to about 50 percent.

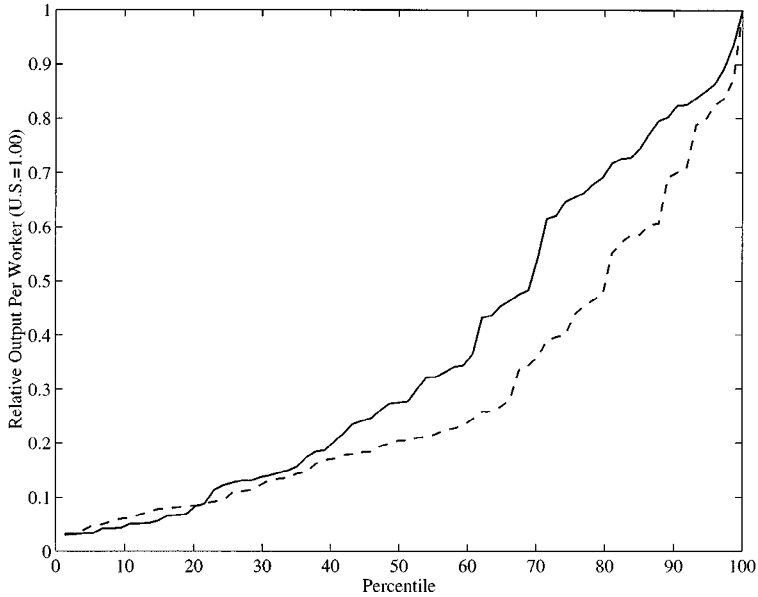

Figure 1. The world income distribution, 1960 and 1990. The dashed line is 1960, and the solid line is 1990. The order of countries differs for the two periods.

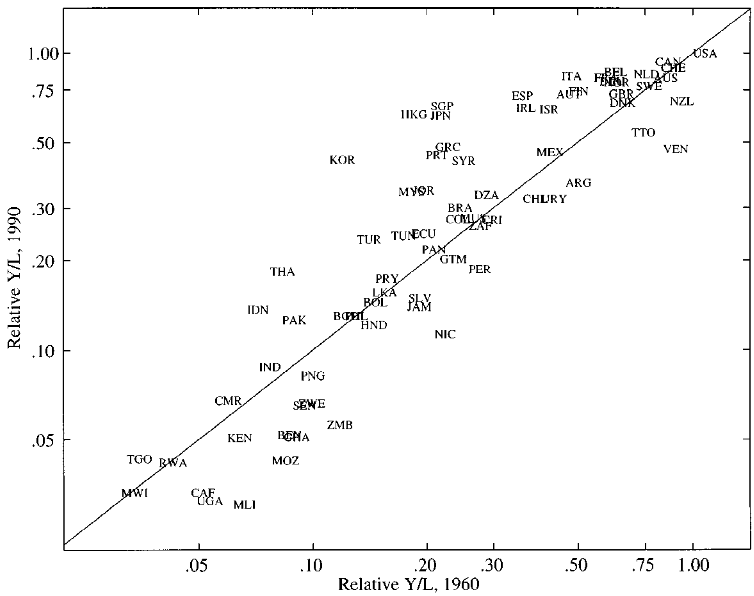

Figure 2. Relative Y/L, 1960 versus 1990 (log scale).

3. Theory

The goal of the remainder of this article is to add a third dimension to the analysis in Figures 1 and 2 to reflect the steady-state distribution of per capita income. This section describes how we use economic theory to estimate this distribution. The economic theory is based on a variation of the neoclassical growth model that contains elements of models by Mankiw, Romer, and Weil (1992) and Lucas (1988).

Let output Y in the economy be produced by physical capital K and skilled labor H according to

$$Y(t) = K(t)^{\alpha}(A(t)H(t))^{1-\alpha}, \tag{1}$$

where A represents labor-augmenting total factor productivity. Skilled labor input is given by

$$H(t) = e^{\phi S(t)}L(t), \tag{2}$$

where L is raw labor input and S is time devoted to skill accumulation by a representative member of the labor force.

Several aspects of this way of modeling human capital deserve mention. First, interpreting S as years of schooling, ϕ is the Mincerian rate of return to a year of schooling (Mincer, 1974). An additional year of schooling increases "effective" labor input by 100ϕ percent and therefore increases the wage by the same amount. Constant returns to scale and the implication that factor payments exhaust output is preserved here by assuming that the human capital is embodied in labor. The exponential structure assumed in the model is traditional in labor economies.[6] Second, we assume there is only a single "type" of labor input. This is motivated by data considerations: in a large sample of countries, we only observe average years of schooling for the entire labor force. This makes it difficult to divide labor input into "skilled" and "unskilled," for example.[7] Finally, in this infinite horizon setup, individuals can spend their time working or accumulating skill, as in Lucas (1988). That is, we interpret S as the fraction of an individual's time endowment spent accumulating skill each period. In this sense, S is more like an investment rate than a capital stock. For example, it is constant along a balanced growth path, rather than growing with the economy.[8]

Letting lowercase letters denote variables normalized by the size of the labor force (so that $h \equiv e^{\phi S}$ for example), output per worker is given by

$$y(t) = k(t)^{\alpha}(A(t)h(t))^{1-\alpha}. \tag{3}$$

Physical capital per worker evolves according to

$$\dot{k}(t) = s_K(t)y(t) - (n(t) + \delta)k(t), \tag{4}$$

where s_K is the investment rate, n is the rate of population growth, and δ is a constant rate of depreciation.

Now consider solving for a balanced growth path, defined as a situation in which (1) all variables grow at constant rates and (2) the physical investment rate, the fraction of time spent accumulating skill, and the population growth rate are constant. It is easy to show that along such a balanced growth path, the growth rates of y and k are equal to the growth rate of A, which we will denote g, while h is constant. We will take the growth rate g as exogenously given, noting that it could be determined by an R&D process in a more complicated model and still be exogenous to policy (as in Jones, 1995). We will also assume the existence of a balanced growth path instead of specifying exactly how s_K, S, and n are determined.

It is then straightforward to solve for the value of per capita output along a balanced growth path:

$$y^*(t) = \left(\frac{s_K}{n+g+\delta}\right)^{\frac{\alpha}{1-\alpha}} hA^*(t), \tag{5}$$

where time indices have been dropped from variables that are constant, and an asterisk (*) is used to signify the balanced growth path for y and A.

It only makes sense to think about the steady-state distribution of per capita income if all economies are growing at the same rate. In the context of the neoclassical model, this requires the exogenous growth rate of technology to be the same in the long run for each country, which we will now assume. How reasonable is such an assumption? At some level it seems plausible. For example, if technological progress is the engine of growth, one might expect that technology transfer will keep countries from diverging infinitely, and one way of interpreting this statement is that the growth rates will ultimately be the same. Indeed, in recent models by Eaton and Kortum (1994), Barro and Sala-i-Martin (1997), and Bernard and Jones (1996b) this is the case. Notice that we do not require the levels of technology to be the same across countries or the growth rates to be the same along a transition path to the steady state.

Under the assumption that all countries asymptotically have the same growth rate of technology, we can consider relative per capita income $\tilde{y}^* \equiv y^*(t)/y^*_{US}(t)$:

$$\tilde{y}^* = \tilde{\xi}_K^{\frac{\alpha}{1-\alpha}} \tilde{h}\tilde{A}^*, \tag{6}$$

where the tildes are used to denote the variables considered relative to the United States and $\xi_K \equiv s_K/(n+g+\delta)$. Asymptotically, the distribution of relative incomes is nondegenerate and characterized by the elements of equation (6).

This equation summarizes an important prediction at the heart of analysis based on a production function and growth accounting. The steady-state distribution of (relative) per capita income is identically a function of the investment rates for physical and human capital, relative TFP levels, and population growth rates. In this approach, no other variables are required to estimate the steady-state distribution. Rather, variables such as preferences, taxes and subsidies, institutional differences, and political uncertainty should affect the steady-state distribution only through one of these other variables.

4. Determinants of the Steady State

Equation (6) tells us how to calculate the long-run distribution of per capita income. To perform this calculation, however, we need data on the parameters (which will be assumed to be constant across countries) α, ϕ, and $g+\delta$; and for the variables (which will be allowed to vary across countries), n, s_K, S, and $\tilde{A}$.

4.1. The Data

In obtaining the parameters related to the shape of the production function, we assume a neoclassical production function without externalities and appeal to estimates previously obtained by the literature. For the exponent on physical capital, we choose the value $\alpha = 1/3$, which matches capital's share in income for a number of countries and is a reasonable value based on empirical studies by Mankiw, Romer, and Weil (1992) and Islam (1995), among others.[9] For the coefficient on schooling, we follow Hall and Jones (1996) and appeal to the extensive literature estimating Mincerian coefficients for a wide range of countries. Based on the review of these studies by Psacharopoulos (1994), we choose $\phi = .10$.[10] We will assume that $g + \delta = .075$. The results presented below are robust to small changes in these parameters. While there is still substantial debate within the literature about the shape of aggregate production function, the neoclassical model is a useful benchmark. Indeed, if one finds some of the results implausible, this may be viewed as a test of the neoclassical approach.

For the remaining variables, nothing in the analysis hinges on whether they are endogenously or exogenously determined. We simply require estimates of the steady-state value of s_K, S, n, and $\tilde{A}$ for each country. Of course, in practice it is very difficult to determine the steady-state values using fundamentals such as preferences, taxes, political instability, and so on. Instead, we proceed in two directions. The first direction is to use recent data from each country to proxy for the steady-state value. For example, for the investment rates and for population growth rates, we use the data for the period 1980 to 1990 in the PWT 5.6 update of the Summers and Heston (1991) data set. For the relative technology level, we use an estimate of the relative level of Harrod-neutral total factor productivity in 1990, as discussed below.

To measure the fraction of time individuals spend accumulating skill, we use the educational attainment data assembled by Barro and Lee (1993).[11] One advantage of this measure is that there is a natural way to forecast the future stock of human capital measured as years of schooling. Enrollment rates of the young today, which are readily observed, determine the average educational attainment of the labor force in the future. Therefore, in forecasting $\tilde{h}$, we take the observed enrollment rates from the 1980s and assume these represent steady-state enrollment rates.[12]

One way of viewing this analysis is as predicting where countries are headed based on the current state of investment rates, population growth rates, and technologies. However, the current state of these variables may be strongly correlated with their long-run values. This view of the data is consistent with the recent study by Easterly, Kremer, Pritchett, and Summers (1993). These authors argue that while differences in growth rates do not show much persistence across decades, differences in the right-hand-side variables of growth regressions—which reflect the underlying determinants of relative income in the long-run—do show substantial persistence. They note, for example, that primary and secondary school enrollment rates are among the most persistent variables in the Barro (1991) growth regression: the correlation across decades for a large sample of countries is noticeably higher than 0.8.[13] Applying their methodology to physical investment rates for the samples considered here, the correlations across decades are also uniformly above 0.8. This suggests that recent data on the determinants of steady-state income may do a good job of predicting their long-run values.

While this first direction receives primary emphasis below, we also consider the robustness of these results by using additional economic theory to determine steady-state values. For example, in one alternative we require the rates of return to physical capital to be equal to reflect a perfect capital mobility assumption. Another examines the behavior of relative incomes after countries have undergone a "demographic transition" that reduces population growth rates to a common value of 1 percent per year.

A shortcoming of the general approach taken in this article is that there is no model of the endogenous (and presumably related) responses of investment rates, schooling, and technology to underlying fundamentals. An alternative and more ambitious approach would be to specify the fundamentals that determine these variables within the context of a theory, to forecast the future of the fundamentals, and then to use the theory to predict the behavior of relative incomes. The present exercise can be viewed as a first step in this direction using a well-studied model.

Before going further, we consider the behavior of the determinants of relative incomes over the last three decades—for instance, are the determinants themselves converging? Figure 3 displays the basic time series data for the determinants by reporting the median value for each continent. In comparing the data for the period 1960 to 1985 with the data for the 1980s, one begins to see the reasons why the distribution of income levels in 1985 may not represent the steady-state distribution, as suggested by Mankiw, Romer, and Weil (1992). For example, physical investment rates among Asian economies show a strong upward trend, and population growth rates in Africa show a slight upward trend in contrast to the decline in the averages for other continents. Primary enrollment rates in OECD countries have maxed out, while enrollment rates on other continents are rising, but this is offset somewhat by the rise in secondary and tertiary enrollment rates among advanced economies. It is exactly these changes that will be reflected in the forecasts of the steady-state income distribution.

4.2. Calculating Relative TFP Levels

The one remaining determinant that we need in order to forecast the steady-state distribution of income is the relative TFP variable. As an estimate of this variable, we use a Harrod-neutral total factor productivity level in 1990, calculated using equation (3). Relative TFP levels are calculated using both physical capital stocks and educational attainment.[14] Note that total factor productivity measures technology broadly defined: this is the "levels" equivalent of the Solow residual and therefore captures everything not already included in the production function.

Table 1 summarizes the TFP calculation for a select sample of countries; levels of A for the complete sample are reported in the appendix. As can be seen immediately by taking logs of equation (3), the log of relative income is a weighted sum of the log of relative

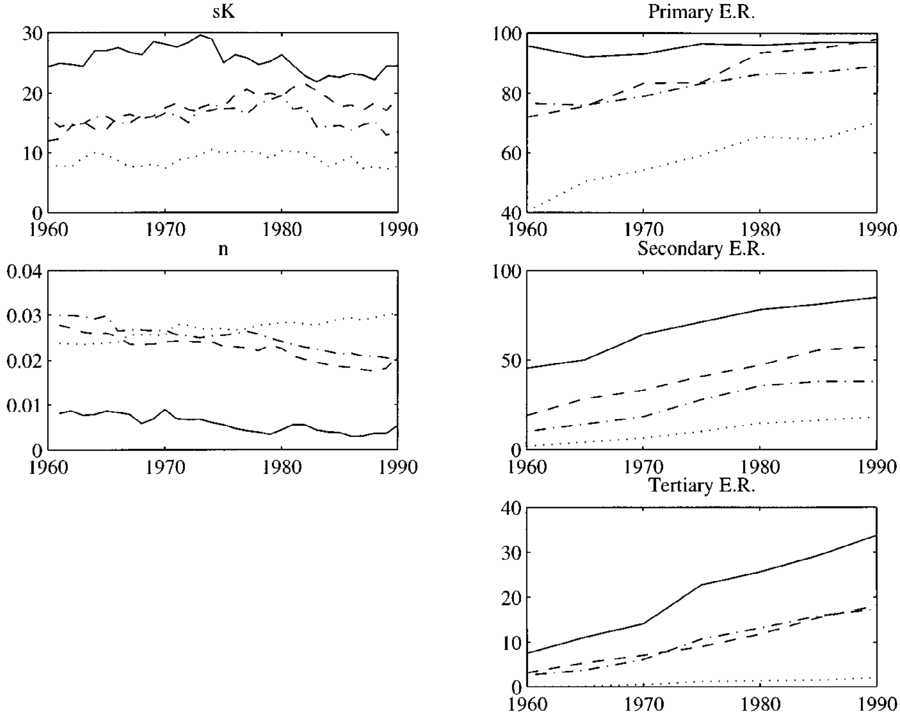

Figure 3. Continent averages for s_K, n, and enrollment rates. Solid line = Europe (plus United States and Canada); dashed line = Asia and Oceania; dash-dot = Americas (excluding United States and Canada); dotted line = Africa. The continent definitions are from Penn World Tables Mark 5.6.

k, h, and A, and it is these contributions that are reported in the table. A few results are worth noting. Germany, for example, has a capital-labor ratio and a TFP level about equal to that of the United States. Its GDP per person is about 22 percent less than that of the United States because of lower educational attainment. Singapore, Hong Kong, and Japan all have incomes about 45 percent lower than the United States, but for very different reasons. Singapore has a capital-labor ratio that is close to the United States, but it has substantially lower educational attainment. Factor inputs are more than enough to account for Singapore's lower income, so that its TFP level is actually about 20 percent *higher* than U.S. TFP. For Hong King, the results are similar, but it is relatively low physical capital that necessitates a relative TFP level greater than that of the United States.[15] Finally, in contrast to Hong King and Singapore, Japan has neither a particularly low capital-labor ratio or particularly low educational attainment, so that a substantial component of its lower output per worker is due to a TFP level that is 18 percent below that of the United States.

A perhaps surprising result of the TFP analysis is that the United States is not the most productive country in the world. The fact that the United States has the highest output per worker is largely attributable to its high level of factor inputs, particularly educational

Table 1. Log relative TFP levels in 1990.

		Contributions		
	$\log \tilde{y}$	$\alpha \log \tilde{k}$	$(1-\alpha)\log \tilde{h}$	$(1-\alpha)\log \tilde{A}$
United States	0.000	0.000	0.000	0.000
West Germany	−0.220	−0.017	−0.217	0.013
United Kingdom	−0.318	−0.171	−0.209	0.062
Singapore	−0.411	−0.136	−0.483	0.207
Hong Kong	−0.477	−0.339	−0.285	0.148
Japan	−0.486	−0.081	−0.222	−0.183
Brazil	−1.203	−0.477	−0.553	−0.172
India	−2.431	−1.036	−0.583	−0.812
Cameroon	−2.693	−1.154	−0.637	−0.902
Mean (74 countries)	−1.419	−0.605	−0.432	−0.383
Standard deviation	1.041	0.505	0.191	0.437

attainment. As shown in appendix Table A1, fifteen of the seventy-four countries have higher TFP levels. Italy and Singapore, the most productive countries, have TFP levels 36 percent higher than the United States. This observation suggests that TFP may reflect more than simply differences in technology. For example, measurement error in any input will translate directly into the mismeasurement of productivity. Because of the accounting setup, if one does not believe the TFP number for a particular country, the source of the error must lie in one of the other terms in equation (3). Hall and Jones (1996) provide a more general analysis of productivity and show that differences in TFP levels across countries largely reflect differences in government policies and institutions.

The last row of Table 1 reports the standard deviation of each component. From this row, one sees that differences in TFP are almost as important as differences in the capital-labor ratio across countries. The actual standard deviation of log TFP (found by dividing .437 by $1-\alpha$) is 0.656, about two-thirds of the standard deviation of $\log y$.

5. The Steady-State Distribution

The main empirical results of this article are reported in Tables 2 and 3 and in Figures 4 to 7. The tables and figures document the steady-state distribution of per capita income under various assumptions. More detailed results for each individual country, including the data on the determinants of the steady-state distribution, are reported in the appendix.

It is easiest to discuss the results in terms of Table 2. The first two rows of the table report some of the characteristics of the distribution of GDP per worker for 1960 and 1990 for the main sample of seventy-four countries. The standard deviation of $\log Y/L$ rises from 0.89 in 1960 to 1.04 in 1990, suggesting an overall divergence of world incomes. The rightmost columns of Table 2 report similar results for a rough measure of consumption per worker. The measure is calculated as $(1-s_K)Y/L$ and therefore corresponds to "potential" consumption rather than actual consumption as it ignores government purchases and net exports. The measure is useful, however, if we wish to discuss welfare rather than

Table 2. Evolution of the income distribution, full sample.

Method	GDP σ	GDP U.S.%	R^2	Consumption σ	Consumption U.S.%
Data for 1960	0.89	100	···	0.83	100
Data for 1990	1.04	100	···	0.97	100
Steady-state distributions:					
(1) Base model	1.13	91	.96	1.06	91
(2) —$A \geq A_{US}$	0.62	86	.71	0.54	89
(3) —Same A	0.59	93	.68	0.51	97
(4) —$A \geq A_{US}$, same h	0.38	66	.47	0.30	68
(5) —Same n	1.09	91	.96	1.01	95
(6) —Open economy	0.86	96	.91	0.91	93

Note: N=74. σ is the cross-sectional standard deviation in the log of the relevant variable. Unless specified otherwise, the steady-state distributions are calculated assuming that s_K, S, n, and A vary across countries, as discussed in the text. The $\bar{R}^2$ measure reflects the fraction of the variance of 1990 log Y/L "explained" by the steady-state distribution. See text.

Table 3. Evolution of the income distribution, OECD.

Method	GDP σ	GDP U.S.%	$\bar{R}^2$	Consumption σ	Consumption U.S.%
Data for 1960	0.55	100	···	0.53	100
Data for 1990	0.31	100	···	0.30	100
Steady-state distributions:					
(1) Base model	0.29	73	.63	0.28	77
(2) —$A \geq A_{US}$	0.19	64	.52	0.17	73
(3) —Same A	0.18	82	.45	0.16	91
(4) —$A \geq A_{US}$, same h	0.13	9	.12	0.11	9
(5) —Same n	0.27	77	.64	0.27	91
(6) —Open economy	0.27	91	.57	0.28	82

Note: N=22. See notes to Table 2.

productivity. Countries may achieve high Y/L with a high investment rate, but this will reduce the consumption share of income. In this model, the golden rule for maximizing steady-state consumption occurs when $s_K = \alpha$; evaluated at $\alpha = 1/3$, increases in s_K will raise steady-state consumption for nearly all countries. Nevertheless, to the extent that per capita income differences are associated with different investment rates, the differences will be smaller in consumption. Notice that in both 1960 and 1990 the United States had the highest per capita income and consumption in the sample: it ranked at the 100th percentile.

Table 3 reports similar results for the sample of twenty-two OECD economies. The familiar convergence result is documented for the 1960 to 1990 period as the standard deviation declines substantially from 0.55 to 0.31 for Y/L and from 0.53 to 0.30 for consumption.

The main portions of these tables, labeled "Steady-state distributions," report the results under six alternative scenarios. The baseline scenario is reported as model (1) and is

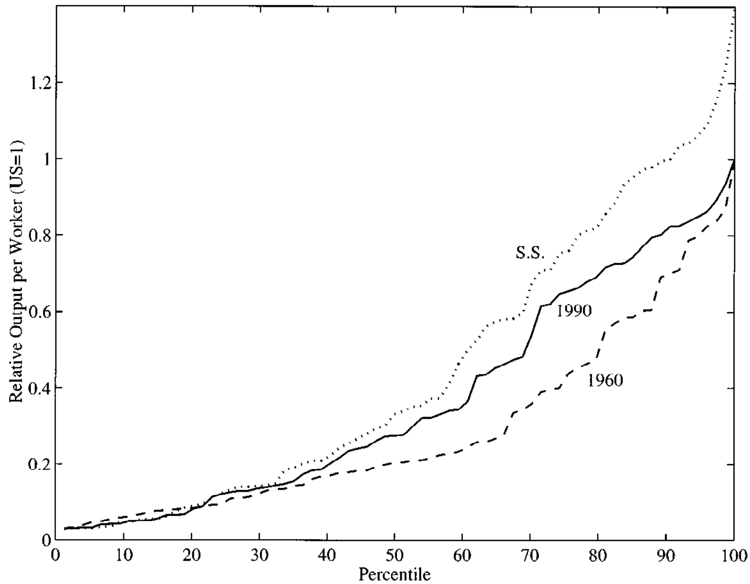

Figure 4. Steady-state distribution, base model.

documented graphically in Figures 4 and 5. In this scenario, the recent averages from the 1980s of s_K, n, and enrollment rates are used to predict the steady-state distribution, assuming no change in the relative TFP levels from 1990. Two important results are evident.

First, the steady-state "world" income distribution is broadly similar to the 1990 distribution, particularly among the poorer half of the sample. The standard deviation rises slightly from 1.04 in 1990 to 1.13 in the steady state, suggesting some continued divergence. The pseudo-$\bar{R}^2$ statistic comparing the logs of relative income in 1990 and the steady state is 0.96.[16] Second, Figures 4 and 5 show that the 1990 and expected steady-state distributions, while similar, exhibit some interesting differences. Economies above the 50th percentile are expected to exhibit additional catch-up to the United States. In fact, a number of economies such as Spain, Singapore, France, Italy, Austria, Switzerland, and Belgium actually overtake the U.S. lead, and the United States falls to the 91st percentile in the world and the 73rd percentile in the OECD. Holding 1990 TFP ratios constant, the world income distribution appears to be characterized by additional divergence at the bottom of the income distribution and convergence and overtaking at the top.

Model (2) and Figures 6 and 7 report the results for the model allowing for nearly complete convergence of technology levels. Specifically, countries with less than the U.S. TFP level are assigned the U.S. value, while the fifteen countries with a higher level of TFP are allowed to maintain their efficiency advantage. To the extent that measurement error is partially responsible for values of $\tilde{A} > 1$, this exception offsets the error. In model (3) below, we will consider the alternative case of identical A's.

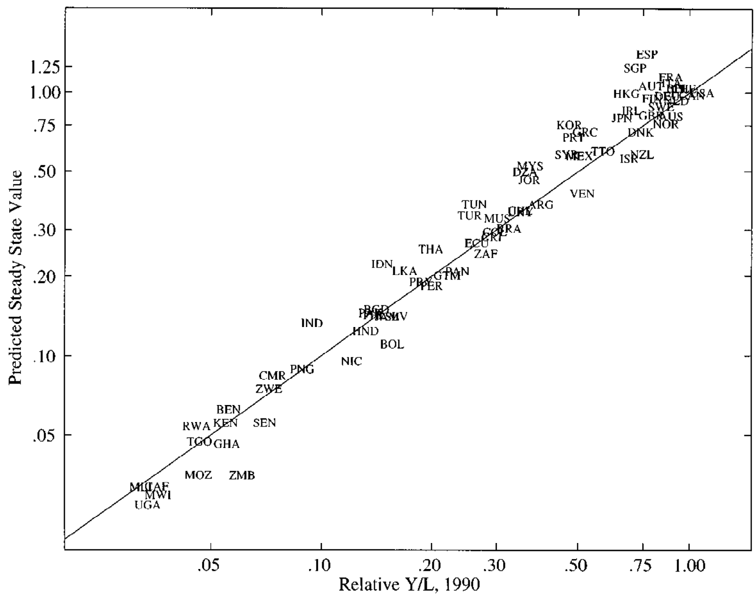

Figure 5. Model (1): Base model.

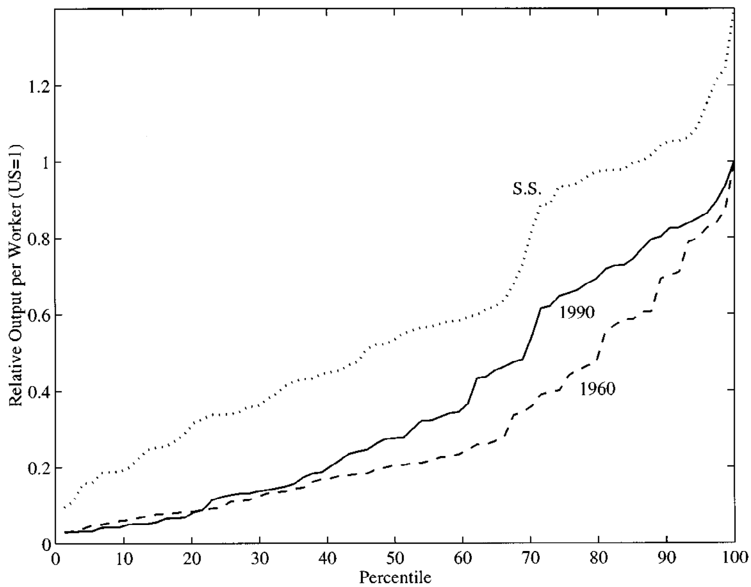

Figure 6. Steady-state distribution, same *A*.

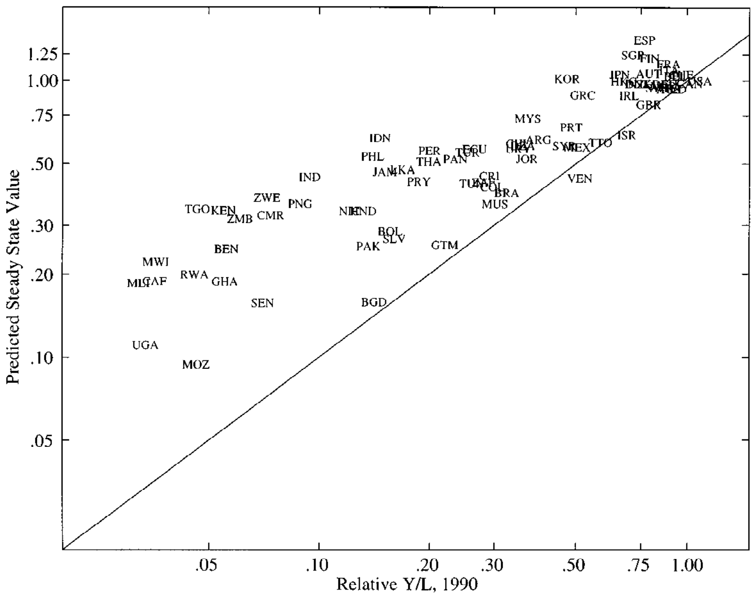

Figure 7. Model (2): Same *A*.

For the world as a whole, near-complete convergence of technology condenses the income distribution significantly, with the standard deviation falling to 0.62. At the top of the income distribution, however, there is additional overtaking, as the convergence of technologies raises the producitivity of many countries that were already close to the United States in steady state. The United States falls from the top of the income distribution to the 86th percentile in the world and the 64th percentile in the OECD. Intuitively, this results from the simple fact that U.S. investment rates are substantially below investment rates for a number of other countries. With identical technologies, these differences dominate. In addition to the countries overtaking the United States according to model (1), Japan, Korea, and Finland all rise to more than the U.S. level under these assumptions.

Model (3) imposes identical values of *A* for all countries. The statistics in Table 2 and 3 show that the results are broadly similar to those for model (2). The main difference is that the United States performs relatively better, falling to the 93rd and 82nd percentiles in the world and the OECD, respectively. The countries with productivity advantages over the United States are allowed to maintain these advantages in model (2) but not in model (3), accounting for the difference. More complete results are reported in appendix Table A1.

These results can be compared to those reported in Table II of Mankiw, Romer, and Weil (1992) using the $\bar{R}^2$ column. They find that, ignoring differences in TFP, the steady-state distribution of log per capita income explains about 75 percent of the variation of the 1985 distribution. For our slightly different sample, slightly different data, and for the year 1990, the estimate is about 68 percent when TFP differences are ignored, as in model (3). More generally, the $\bar{R}^2$ statistics indicate how similar the steady-state distribution is to the 1990 distribution.

5.1. *Alternative Scenarios*

Model (4) considers what happens to the distribution if relative technology levels converge to the technology level of the United States and the countries have the same educational attainment. Thus, this scenario downplays determinants in which the United States performs well and plays up investment and population growth, determinants for which U.S. performance is relatively weak. Not surprisingly, this alters the distribution significantly. First, there is substantial convergence in the income distribution; the standard deviation falls from 1.04 in 1990 to only 0.38. Second, this shift leads to a number of countries overtaking the United States in productivity, as the United States falls to the 66th percentile in the world and only the 9th percentile in the OECD. Results for specific countries may be found in the appendix.

Model (5) is a simple way of examining the importance of a demographic transition. In this model, all countries have the same population growth rate of 1 percent in steady state. According to the results in Tables 2 and 3, this change has very little impact on the results; the statistics are very close to those for the base scenario in model (1). The explanation for the insensitivity of the results to population growth is easily seen by computing the semi-elasticity of income with respect to population growth from equation (6). For typical parameter values, this elasticity is very small.

Model (6) considers the open economy scenario. According to this scenario, the marginal products of physical capital are equated across countries. This means that $(n + g + \delta)/s_K$ is equal across countries.[17] Notice that this scenario emphasizes differences in TFP and human capital investment as determinants of the steady-state distribution. These are the determinants for which the United States performs relatively well, and this intuition is confirmed in the results. Under this scenario, although the standard deviation falls back to its 1960 level, the United States remains very close to the top of the world income distribution.

5.2. *The Return to Capital*

The results so far for the steady-state distribution of per capita income can be partially summarized as follows. Recent data on investment rates, educational attainment, population growth rates, and relative technologies suggest that the long-run distribution of income involves the United States falling from its leadership position. However, an open economy scenario in which the marginal products of physical capital are equalized across countries mitigates this change.

This section considers the differences in the rates of return to capital across countries in 1990 and in the steady state according to the various models. The rate of return to capital in the steady state is given by $\alpha(n + g + \delta)/s_K$. That is, it varies across countries only because of variation in population growth and the physical investment rate. In the context

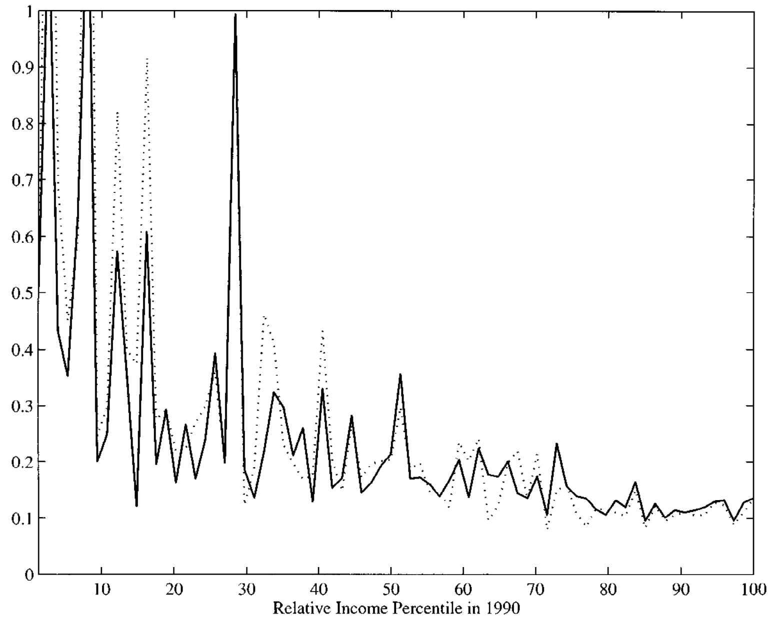

Figure 8. Rates of return to capital in 1990 and steady state. The solid line corresponds to 1990; the dotted line corresponds to the steady state.

of the various models considered here, the steady-state rate of return to capital for a given country is the same across models (1) through (5).[18]

Figure 8 plots the marginal products of capital in 1990—that is, $\alpha Y/K$—and in the steady state. A distinction between countries with relative income above and below the 30th percentile is evident. Below the 30th percentile, there is enormous variability in rates of return, with some countries apparently possessing marginal products of capital greater than 100 percent. However, above the 30th percentile (and especially above the 50th percentile), there is a surprising amount of uniformity in the marginal products of capital. For example, Japan has a marginal product of capital of 10.6 percent in 1990, compared to 13.5 percent for the United States in 1990. Values for selected countries are reported in Table 4.

The steady-state rates of return are fairly similar to the rates of return for 1990, at least for countries with relative income in 1990 greater than the 30th percentile. For the countries reported in Table 4, the steady-state rates of return range only mildly, from a low of 8 or 9 percent in Japan and Singapore to a high of 15 percent for the United Kingdom and Hong Kong. The steady-state rate of return for the United States is almost identical to its 1990 level, at 13.4 percent.

These calculations suggest that the various models considered here do not imply enormous differences in rates of return to capital in the steady state, at least for countries above the

Table 4. Rate of return to capital, selected countries.

	1990	S.S.
United States	.135	.134
France	.114	.106
West Germany	.114	.105
United Kingdom	.164	.150
Singapore	.135	.085
Hong Kong	.233	.150
Japan	.106	.079

Note: The steady-state rate of return is given by $\alpha(n+g+\delta)/s_K$, for models (1) through (5). For model (6), the rates of return are equated across countries.

30th percentile of the income distribution in 1990. Moreover, the differences predicted for the steady state are roughly similar to the differences present in 1990. The differences are sufficiently small that "country risk" such as political or macroeconomic instability could potentially explain the differences. In this sense, the scenarios discussed earlier do not necessarily imply implausible differences in rates of return across countries. The predictions of those models, then, especially regarding the relative position of the United States in the long-run, may not be easy to dismiss.

6. Conclusion

What will the steady-state distribution of per capita income look like? To answer this question, we consider a neoclassical growth model in which production depends on four elements: physical capital, human capital, labor, and technology. For the model considered here, the steady-state income distribution is a function only of the steady-state investment rate, the fraction of time spent accumulating skill, the population growth rate, and the relative steady-rate technology (total factor productivity) levels. Other considerations emphasized in empirical work such as political instability, macroeconomic policy, taxes and subsidies, and so on must work through one of these four variables.

Recent data on each of these determinants allows us to estimate the steady-state distribution of per capita income, and several main results emerge. First, if the 1990 distribution of TFP levels is the steady-state distribution, then the steady-state distribution of per capita income will look broadly similar to the current distribution: most economies are reasonably characterized as at their steady state levels in 1990. Second, economies above the 50th percentile of the income distribution are generally expected to exhibit additional "catch-up" to the United States, and several of these economies are even expected to overtake the U.S. lead based on current policies. In contrast, economies below the 50th percentile typically are predicted to remain very close to their 1990 relative income levels. These two facts imply that, holding differences in technology levels constant, the world income distribution will be characterized by additional divergence at the bottom and convergence and overtaking at the top. Third differences in TFP levels across countries are substantial, and changes in relative TFP levels can have important effects on the steady-state income distribution. Finally, current dynamics imply a future income distribution in which the United States is surpassed by a number of other countries. For example, the main models suggest that the United States would fall from the 100th percentile to the 86th percentile in the income distribution. Countries such as France, Singapore, and Spain are expected to have incomes ranging from 115 percent to 140 percent of U.S. income under this scenario. The explanation of this result is twofold. First, the U.S. lead in educational attainment cannot completely make up for its low investment rate. Second, a number of countries have higher TFP levels than the United States.

Given that the results are partially driven by low levels of physical investment in the United States, a natural question is whether the steady-state distributions imply implausibly large differences in the rates of return to investment. The final part of the article argues that this is not the case. The steady-state differences in rates of return are surprisingly small and look very much like the differences observed in 1990. There may be little incentive, then, for investment rates in physical capital among advanced economies to converge.

Data Appendix

This appendix discusses the data used in the paper. "SH" refers to the Penn World Tables Mark 5.6 of Summers and Heston (1991) obtained via ftp from nber.harvard.edu.

GDP Per Worker

The "rgdpw" series from the SH. s_K is the "i" series for investment rates from SH, averaged from 1980 to 1990. n is population growth rates, calculated as the change in the log of the SH population series, averaged from 1980 to 1990. Labor force growth rates are not used because of discrete breaks in the trend in the labor force series for a number of African countries around the year 1986 (for example, Ghana, Kenya, Nigeria, Mali, and Zimbabwe).

Physical Capital Stocks

The capital stock is calculated by summing investment from its earliest available year (1960 or before) to 1990 using a depreciation rate of 6 percent and an initial capital stock determined by the initial investment rate divided by the growth rate of investment during the subsequent ten years. Because the initial stock will have had at least thirty years to depreciate, our capital stock measure is quite insensitive to the initial value.

Educational Attainment (S)

Educational attainment is used in two ways. For computing the total factor productivity level, the 1985 levels from Barro and Lee (1993) are used because no 1990 data is available.

For forecasting future values of S, enrollment rate data from Barro and Lee (1996) are used. Data on primary and secondary enrollment rates are "net" while data on tertiary enrollment rates are "gross." The forecasts are constructed under the assumption that 1985 to 1990 enrollment rates represent steady-state outcomes. Then, the steady-state stocks are computed by following the basic methodology used by Barros and Lee for computing stocks. I will describe the method for obtaining primary schooling stocks; the method for secondary and tertiary stocks is similar, and the total years of schooling is obtained by summing the schooling at three levels:

1. Compute an expected probability of completion (call it π_i) by averaging the 1985 and 1990 values for completion rates (fraction completing primary school divided by fraction attaining primary school).

2. Compute the stock as

$$h^*_{pi} = DUR_{pi}(\pi_i + .5 * (1 - \pi_i)),$$

where DUR_{pi} is the duration of primary schooling in country i (durations vary substantially across countries, but not much over time, according to Barro and Lee).

For primary school, we assume that those who do not complete receive half of the duration.

Table A1 lists several different variables for each country.

Table A1. Country data.

	Determinants				Relative Y/L							
Country	s_K	S	$\tilde{A}$	n	1960	1990	(1)	(2)	(3)	(4)	(5)	(6)
United States	.210	11.4	100	.009	100	100	100	100	100	100	100	100
Canada	.253	9.8	105	.010	80	93	98	98	94	115	98	89
Switzerland	.306	9.8	99	.006	82	89	104	105	105	123	102	84
Belgium	.207	10.3	111	.001	59	86	104	104	94	116	99	100
Netherlands	.210	9.1	114	.006	70	85	94	94	82	117	91	91
Italy	.244	7.9	136	.002	45	84	109	109	80	154	104	97
France	.252	9.1	128	.005	55	83	115	115	90	145	112	102
Australia	.269	9.8	87	.015	79	82	81	93	93	110	84	74
West Germany	.245	9.7	102	.003	57	80	97	97	95	115	93	86
Norway	.276	9.2	79	.004	58	80	76	96	96	119	73	64
Sweden	.212	10.3	94	.003	71	77	89	94	94	105	85	85
Finland	.320	10.9	79	.004	47	74	95	121	121	128	92	75
United Kingdom	.171	9.0	110	.002	60	73	82	82	75	104	78	86
Austria	.247	9.4	114	.002	44	73	106	106	93	130	102	94
Spain	.239	11.1	131	.004	34	72	140	140	107	145	136	127
New Zealand	.241	10.3	60	.008	87	69	58	98	98	108	58	54
Denmark	.215	10.4	73	.000	61	68	71	98	98	107	67	66

Table A1 continued.

	Determinants				Relative Y/L							
Country	s_K	S	$\tilde{A}$	n	1960	1990	(1)	(2)	(3)	(4)	(5)	(6)
Singapore	.361	8.2	136	.017	20	66	124	124	91	172	130	99
Ireland	.238	9.1	97	.003	34	65	86	89	89	111	82	77
Israel	.196	7.7	.88	.018	40	65	56	64	64	92	59	61
Hong Kong	.195	9.7	125	.012	17	62	99	99	80	118	101	105
Japan	.338	9.3	76	.006	20	62	80	105	105	130	78	62
Trinidad/Tobago	.137	8.2	104	.013	69	54	60	60	57	82	61	75
Greece	.199	10.2	80	.005	21	48	71	89	89	100	69	71
Venezuela	.154	5.7	93	.026	84	47	41	44	44	78	45	53
Mexico	.160	6.1	118	.020	39	46	57	57	49	97	61	70
Portugal	.207	5.7	114	.001	20	45	68	68	60	119	64	65
Korea	.299	9.9	74	.012	11	44	75	102	102	118	76	64
Syria	.149	7.0	121	.033	23	43	58	58	48	90	66	78
Argentina	.146	8.5	61	.014	46	36	37	61	61	82	38	46
Jordan	.164	7.7	89	.041	18	34	46	52	52	76	54	61
Malaysia	.282	7.6	72	.026	17	34	53	73	73	106	57	49
Algeria	.236	6.4	86	.029	27	33	50	58	58	96	55	52
Chile	.210	6.5	60	.017	36	32	35	59	59	96	37	37
Uruguay	.136	7.6	62	.006	40	32	35	57	57	82	34	43
Brazil	.169	3.7	77	.021	23	30	30	39	39	85	32	36
Mauritius	.096	5.1	92	.011	24	28	33	36	36	67	33	49
Colombia	.155	4.6	71	.020	22	27	29	41	41	81	31	36
Costa Rica	.169	5.5	62	.027	28	27	28	45	45	82	31	34
South Africa	.170	4.8	57	.025	26	26	24	43	43	83	27	29
Ecuador	.195	6.9	47	.026	18	25	27	56	56	88	29	30
Tunisia	.123	6.2	88	.023	16	24	37	42	42	71	40	53
Turkey	.221	5.9	62	.023	13	23	34	55	55	95	37	36
Panama	.157	6.9	40	.021	19	22	21	52	52	81	22	26
Guatemala	.080	3.5	79	.028	22	20	20	25	25	56	22	36
Peru	.184	6.9	33	.022	26	19	18	56	56	87	20	21
Thailand	.185	5.8	50	.019	8	18	25	51	51	89	27	28
Paraguay	.179	4.9	44	.031	15	17	19	43	43	83	21	23
Sri Lanka	.129	6.7	44	.014	14	16	21	48	48	76	22	27
El Salvador	.071	3.8	52	.013	18	15	14	27	27	57	14	25
Bolivia	.072	5.0	39	.025	14	14	11	29	29	54	12	21
Jamaica	.149	5.5	30	.010	18	14	14	47	47	84	14	17
Indonesia	.255	6.1	36	.018	7	14	22	62	62	105	23	21
Bangladesh	.033	3.0	94	.022	11	13	15	16	16	37	16	41
Philippines	.163	7.1	27	.024	12	13	14	53	53	81	15	17
Pakistan	.098	2.5	58	.031	8	13	15	25	25	61	16	24
Honduras	.121	4.5	37	.033	13	12	12	34	34	67	14	18
Nicaragua	.126	4.0	28	.027	21	11	10	34	34	71	11	14
India	.144	5.9	30	.021	7	9	13	45	45	78	14	17
Papua New Guinea	.150	3.5	25	.023	9	8	9	36	36	78	10	11
Cameroon	.118	4.1	26	.028	6	7	8	33	33	68	9	12
Zimbabwe	.131	5.2	20	.034	9	7	8	38	38	70	9	11
Senegal	.038	2.5	35	.029	9	7	6	16	16	38	6	15
Zambia	.098	5.0	11	.035	11	6	4	32	32	60	4	6
Benin	.089	2.8	25	.031	8	5	6	25	25	58	7	11
Ghana	.044	3.7	25	.033	8	5	5	19	19	40	5	11
Kenya	.126	4.5	16	.037	6	5	6	34	34	67	6	8

Table A1 continued.

	Determinants				Relative Y/L							
Country	s_K	S	$\tilde{A}$	n	1960	1990	(1)	(2)	(3)	(4)	(5)	(6)
Togo	.146	3.8	14	.033	3	4	5	34	34	74	5	6
Mozambique	.017	1.2	37	.026	8	4	4	9	9	26	4	14
Rwanda	.058	2.7	27	.029	4	4	5	20	20	48	6	11
Central African Republic	.049	2.8	17	.026	5	3	3	19	19	44	3	7
Malawi	.080	2.4	13	.033	3	3	3	22	22	55	3	5
Uganda	.018	2.3	25	.024	5	3	3	11	11	27	3	10
Mali	.066	1.2	17	.025	6	3	3	19	19	52	3	6

Note: See text. Columns (1) through (6): (1) base model, (2) $A \geq A_{US}$, (3) same A, (4) $A \geq A_{US}$, same h, (5) same n, (6) open economy.

Acknowledgments

I would like to thank Susanto Basu, Andrew Bernard, Michael Kremer, Greg Mankiw, Danny Quah, John Williams, two referees, and seminar participants at the Federal Reserve Banks of Dallas and San Francisco, University of California at Berkeley, and University of California at Santa Cruz for helpful comments. The Center for Economic Policy Research at Stanford, the Hoover Institution, and the National Science Foundation (SBR-9510916) provided financial support.

Notes

1. A partial list of this work includes Barro and Sala-i-Martin (1991), Bernard and Jones (1996a), and Evans (1995). See also the methodological discussion in Bernard and Durlauf (1996).
2. Implicit in this analysis is the assumption that business cycle variation within a country in steady state is relatively small.
3. Hall and Jones (1996) attempt to explain these differences using government policies and institutions.
4. We use GDP per worker as our measure of “per capita income.” Ultimately, we are interested in making welfare comparisons across countries. For this purpose, one does not want to follow the national accounts data in drawing a distinction between market production and home or nonmarket production. Viewing GDP per worker as a proxy for per capita income is a coarse correction for this flaw.
5. The sample of countries, listed in the data appendix, is essentially the nonoil sample of ninety-eight countries from Mankiw, Romer, and Weil (1992) for which human capital data is available from Barro and Lee (1993) and for which 1990 GDP data is available in the PWT 5.6 release of the Summers and Heston (1991) data set. This reduces the sample to seventy-four countries. The picture is similar for other large samples.
6. See Bils and Klenow (1996) for the original application of this idea.
7. Combining (1) and (2), the production function is still somewhat similar to the production function assumed in Mankiw, Romer, and Weil (1992), apart from the exponential. The aggregation of individuals with different levels of schooling is exact if H is calculated as the sum of the exponentials. Calculating H as the exponential of average years of schooling is valid as an approximation to exact aggregation to the extent that ϕS is small.
8. This distinction together with the exponential structure assumed in (2) may account for the empirical result that the growth rate of years of schooling is either uncorrelated or negatively correlated with the growth rate of per capita GDP. Benhabib and Spiegel (1994), Islam (1995), and Pritchett (1996) document this empirical finding.

9. Bernard and Jones (1996a) discuss the difficulties of defining total factor productivity when the exponents of the production function differ across countries and suggest imposing equality as one reasonable solution.
10. Psacharopoulos reports Mincerian coefficients ranging from .068 in the OECD to .134 in Sub-Saharan Africa and an average value across countries of .101. This range seems quite small relative to what one might guess about variation in the capital share across countries.
11. The educational attainment data is measured as years of schooling rather than as a fraction of time, but since our calibration of ϕ is also based on years of schooling, this is appropriate.
12. The exact forecasting method is based on the method Barro and Lee (1993) use to compute educational attainment and is discussed in the appendix.
13. See Figure 5 of their paper.
14. See the appendix for details on the construction of the capital stock. Educational attainment data are from 1985 because 1990 data were not available.
15. The results for physical and human capital in Hong Kong and Singapore are consistent with Young (1992). The result for TFP is not inconsistent with Young because his results are for growth rates rather than levels. In fact, the high levels of TFP may partially explain the low growth rate.
16. The $\bar{R}^2$ is really a pseudo-$\bar{R}^2$. It is calculated by considering the difference between the log of per capita income in 1990 and the log of per capita income in the steady state. The pseudo-$\bar{R}^2$ is then computed as (one minus) the ratio of the variance of this difference to the variance of the 1990 log income.
17. For calculating consumption in the open economy scenario, it is important to distinguish between saving and investment. Steady-state consumption is calculated as $c = (1 - s)y(1 - \alpha + \alpha s/i)$, where s is the saving rate and i is the open economy investment rate.
18. Of course, the open economy model equates these rates of return across countries, so that the distribution there is degenerate.

References

Abramovitz, M. (1986). "Catching Up, Forging Ahead and Falling Behind," *Journal of Economic History* 46, 385–406.

Barro, R. (1991). "Economic Growth in a Cross-Section of Countries," *Quarterly Journal of Economics* 106, 407–443.

Barro, R., and J. Lee. (1993). "International Comparisons of Educational Attainment," *Journal of Monetary Economics* 32, 363–394.

Barro, R., and J. Lee. (1996). "International Data on Education," Mimeo, Harvard University.

Barro, R., and X. Sala-i-Martin. (1991). "Convergence Across States and Regions," *Brookings Papers on Economic Activity*, 107–158.

Barro, R., and X. Sala-i-Martin. (1997). "Technological Diffusion, Convergence, and Growth," *Journal of Economic Growth* 2, 1–26.

Baumol, W.J. (1986). "Productivity Growth, Convergence and Welfare: What the Long-Run Data Show," *American Economic Review* 76, 1072–1085.

Benhabib, J., and M. Spiegal. (1994). "The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-Country Data," *Journal of Monetary Economics* 34, 143–173.

Bernard, A.B., and S.N. Durlauf. (1996). "Interpreting Tests of the Convergence Hypothesis," *Journal of Econometrics* 71, 161–173.

Bernard, A.B., and C.I. Jones. (1996a). "Comparing Apples to Oranges: Productivity Convergence and Measurement Across Industries and Countries," *American Economic Review* 86, 1216–1238.

Bernard, A.B., and C.I. Jones. (1996b). "Technology and Convergence," *Economic Journal* 106, 1037–1044.

Bils, M., and P. Klenow. (1996). "Does Schooling Cause Growth or the Other Way Around?," Mimeo, University of Chicago Graduate School of Business.

Easterly, W., M. Kremer, L. Pritchett, and L. Summers. (1993). "Good Policy or Good Luck? Country Growth Performance and Temporary Shocks," *Journal of Monetary Economics* 32, 459–483.

Eaton, J., and S. Kortum. (1994). "International Patenting and Technology Diffusion," Mimeo, Boston University.

Evans, P. (1995). "How Fast Do Economies Converge," Mimeo, Ohio State University.

Hall, R.E., and C.I. Jones. (1996). "The Productivity of Nations," NBER Working Paper No. 5812.

Islam, N. (1995). "Growth Empirics: A Panel Data Approach," *Quarterly Journal of Economics* 110, 1127–1170.

Jones, C.I. (1995). "R&D-Based Models of Economic Growth," *Journal of Political Economy* 103, 759–784.

Lucas, R.E. (1988). "On the Mechanics of Economic Development," *Journal of Monetary Economics* 22, 3–42.

Mankiw, N.G., D. Romer, and D. Weil. (1992). "A Contribution to the Empirics of Economic Growth," *Quarterly Journal of Economics* 107, 407–438.

Mincer, J. (1974). *Schooling, Experience, and Earnings*. New York: Columbia University Press.

Pritchett, L. (1996). "Where Has All the Education Gone?," World Bank, Policy Research Working Paper No. 1581.

Psacharopoulos, G. (1994). "Returns to Investment in Education: A Global Update," *World Development* 22, 1325–1343.

Quah, D. (1993). "Galton's Fallacy and Tests of the Convergence Hypothesis," *Scandinavian Journal of Economics*, 95, 427–443.

Quah, D. (1996). "Convergence Empirics Across Economies with (Some) Capital Mobility," *Journal of Economic Growth*, 1, 95–124.

Solow, R.M. (1956). "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics* 70, 65–94.

Summers, R., and A. Heston. (1991). "The Penn World Table (Mark 5): An Expanded Set of International Comparisons: 1950–1988," *Quarterly Journal of Economics* 106, 327–368.

Young, A. (1992). "A Tale of Two Cities: Factor Accumulation and Technical Change in Hong Kong and Singapore," in O. Blanchard and S. Fischer (eds.), *NBER Macroeconomics Annual*. Cambridge, MA: MIT Press.